Remarks

Claims 2-14, as amended, are presented for examination. Reconsideration is respectfully requested. New claim 15 has been added in response to the first office action.

Claims 3-14 stand rejected under 35 USC 112, the examiner has presented several reasons why the claims are indefinite. The claims have been amended in order to obviate the examiner's rejection.

Claim 1 stands rejected under 35 USC 102 as being anticipated by Ganeshan, U.S. 5,843,303, or Sung et al.. U.S. 5,207,891. In addition, claim 2 stands rejected under 35 USC 103(a) as being unpatentable over Ganeshan, U.S. 5,843,303, or Sung et al., U.S. 5,207,891, in view of Jones et al., U.S. 5,969,237.

None of the cited references are relevant to the claimed invention. The present invention is method to determine if asphaltenes aggregates are present in petroleum oils and oil mixtures using small angle neutron scattering (SANS) and steps to disaggregate the asphaltenes so that the asphaltenes remain soluble. The cited references do not disclose the disaggregation of asphaltenes nor do they disclose SANS to study asphaltene aggregation.

Ganeshan (U.S. 5,843,303) discloses a process to remove asphaltenes from residuum oils using a steam stripping technique. Ganeshan's invention teaches desasphalting residua through steam stripping of a resid that has contacted a light hydrocarbon solvent at an elevated pressure and temperature. Ganeshan does _not_ teach the disaggregation of asphaltenes in an incompatible mixture by mild pre-heating at ambient pressure. Ganeshan's invention forces the asphaltenes to aggregate and come out of solution through the introduction of a very light oil, and then these aggregated

asphaltenes in the light oil are steam stripped to produce a deasphalted oil and an asphaltene product stream. Ganeshan's process of steam stripping after the pressurization and heating step prevents the asphaltenes from disaggregating, since the lighter components of the oil are removed. Thus, Ganeshan's invention does not rely upon heating at ambient pressure to disaggregate the asphaltenes, and, in fact, teaches the opposite of the present invention. The asphaltenes in Ganeshan are removed as a product stream (solid stream) of asphaltenes (see col. 1, lines 35-38, col. 2, lines 40-41). In the present invention, the asphaltenes are disaggregated back into solution.
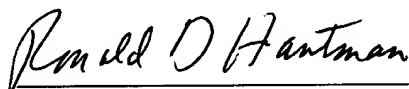
Sung, et al. (U.S. 5,207,891) discloses a composition covering various asphaltene dispersants. The reference to heating in column 7, lines 10-15 is related to performing an ASTM spot test to determine the performance of their dispersants. They use heating to reduce the viscosity of the oil in order to permit placement on the filter paper. They do not use heating to disaggregate asphaltenes. After the heating step, the asphaltenes will aggregate and, therefore, can be measured. Thus, Sung, et al. does not use heating to disaggregate the asphaltenes and does not use heating to prevent re-aggregation.

Jones, et al. (U.S. 5,969,237) describes an acoustic method for probing asphaltene agglomeration in hydrocarbon liquids. This invention relies upon a very different method than small angle neutron scattering (SANS) to probe this process. Furthermore, it does not teach anything about asphaltene disaggregation upon heating. The reference in col. 2, lines 19-29 indicates that SANS is a known technique for examining asphaltenes dispersed in 1-methy-naphthalene-D10. This is a deuterated hydrocarbon solvent. That is, the hydrogen atom have been replaced by deuterium. This is not a petroleum oil nor a refinery process stream. The present invention uses SANS for non-deuterated hydrocarbons that are found in refinery streams. It is not obvious that SANS could be used to probe asphaltenes in non-deuterated oils. Furthermore, Jones used deuterated solvents to probe nanoscale "particles" that are not

known to foul process equipment. In fact, Jones' reference to the cited work claims that larger scale particles (what we refer to as micronscale asphaltene aggregates) are not measureable using SANS, (see Jones, col. 2, lines 24-26). By contrast, the present invention shows that you can measure the larger scale particles using SANS, see specification, page 6, paragraph 0017.

Clearly, the cited references do not disclose heating to disaggregate asphaltenes nor do they disclose SANS to determine asphaltene aggregation. Applicant respectfully requests that a timely Notice of Allowance be issued in this case.

Respectfully submitted,

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[X] Pursuant to 37 CFR 1.34(a)

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Version with Markings to Show Changes Made

In the Claims:

Claims 1-14 have been amended as follows:

1. (Amended) A method to disaggregate asphaltenes in petroleum oils and [oil] mixtures <u>of petroleum oils, and/or refinery process streams</u> comprising mild heating, <u>the disaggregated asphaltenes remaining soluble in the petroleum oils and mixtures of petroleum oils and/or refinery process streams</u>.

2. (Amended) The method of claim 1 further comprising the step of determining the presence of asphaltene aggregates by irradiating said petroleum oils and [oil] mixtures <u>of petroleum oils and/or refinery process streams</u> with neutrons and determining small angle neutron scattering (SANS) intensity, I, as a function of wavenumber, q, <u>wherein said scattering intensity includes a coherent component and an incoherent component</u>.

3. (Amended) The method of claim 2 wherein said neutron scattering wavenumber, q, is in the range $10^{-4} \text{ Å}^{-1} \leq q \leq 1 \text{ Å}^{-1}$[, preferably $10^{-3} \text{ Å}^{-1} \leq q \leq 10^{-1} \text{ Å}^{-1}$].

4. (Amended) <u>The</u> [A] method <u>of claim 3 wherein</u> [to determine] the [regimes of] compatibility and incompatibility of petroleum oils and mixtures of petroleum oils and/or refinery process streams <u>are determined by</u> [using] fitting [of] $I(q)$ [in claim 2] to an equation based on a physical model that contains <u>coherent components,</u> [contributions] a strongly decaying <u>component</u> [feature] to describe the surface scattering of asphaltene aggregates at <u>the</u> [low] q[,] <u>near its lower range (low-q),</u> a plateau [feature] <u>component</u> with a rolloff <u>for</u> [at higher] q <u>near its upper range (high-q)</u> to describe the asphaltene particles, and a constant to describe the [high] q incoherent [scattering] <u>component</u>.

5. (Amended) The method of claim 4 wherein said equation is given by [Equation (1).]

$$I(q) = I_{incoh} + I_L / \left(1 + q^2 \xi^2\right) + I_{surf} \left(q / q_1\right)^{-\alpha},$$

wherein, I_{incoh} is the constant high-q incoherent scattered neutron intensity, I_L is the low-q plateau intensity of the Lorentzian (second term), ξ is the correlation length (proportional to the radius of gyration of an asphaltene particle), I_{surf} is the low-q value of the intensity due to surface scattering from asphaltene aggregates, α is the absolute value of the logarithmic slope of $I(q)$ at low q, and q_1 is fixed by the lowest q in the range.

6. (Amended) The method of claim 5 wherein [the criterion for] incompatibility is determined by the concavity of the low-q plateau intensity of the asphaltene particles, I_L, as a function of the volume fraction of mixing, ϕ_m.

7. (Amended) The method of claim 5 wherein [the criterion for] incompatibility is determined by the systematic deviation of I_L, as a function of mixing volume fraction from [the] a hard sphere prediction [given by Equation (2)].

8. (Amended) The method of claim 5 wherein [the criterion for] incompatibility is determined by [the] a maximum in the correlation length, ξ [given by Equation (2)].

9. (Amended) The method of claim 5 wherein [the criterion for] incompatibility is determined by the dominance of the low-q value of the surface

scattering intensity, I_{surf}, over the sum of the low-q plateau intensity of the asphaltene particles, I_L, and the incoherent scattering intensity, I_{incoh}.

10. (Amended) The method of claim 5 wherein [the criterion for] incompatibility is determined by the power law exponent, α, exceeding a value of three.

11. (Amended) A method to estimate the volume fraction of asphaltene aggregates, ϕ_{agg}, in incompatible petroleum oil and/or refinery process stream mixtures [based on] from a difference between I_L, the low-q plateau intensity corresponding to the asphaltene particles, [I_L, determined in claim 5 at different volume fractions of mixing, ϕ_m,] and [a prediction for the behavior of this] I_{HS}, the intensity [expected] for [spherical particles interacting by contact repulsions] perfect hard spheres in the absence of aggregation, wherein I_L, and I_{HS} are determined at different volume fractions of mixing, ϕ_m.

12. (Amended The method of claim 11 wherein the equation to estimate the volume fraction of asphaltene aggregates, ϕ_{agg}, is given by [Equations (2) and (3)] the difference between the measured valve of I_L (ϕ_m) and the I_L (ϕ_m) for perfect hard spheres in the absence of aggregation.

13. (Amended) The method of claim [2] 5 wherein the total surface area of asphaltene aggregates per unit volume of the petroleum oil, S_V, is determined from the [amplitude of the] surface scattering intensity, I_{surf}, [from asphaltene aggregates] at low wavenumbers, q.

14. (Amended) The method of claims 12 and 13 wherein the average length scale, R, associated with the internal structures of the asphaltene aggregates is [estimated using Equation (4)] determined from the ratio of the volume fraction of asphaltene aggregates and the total surface area of asphaltene aggregates.